भारतीय मानक
Indian Standard

IS 1604 : 2022

वायुयानों में प्रयुक्त गैसोलीन — विशिष्टि

(पांचवां पुनरीक्षण)

Aviation Gasoline — Specification

(Fifth Revision)

ICS 49.050; 75.160.20

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भारतीय मानक ब्यूरो
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July 2022 **Price Group 6**

Petroleum and their Related Products of Synthesis or Biological Origin Sectional Committee, PCD 03

FOREWORD

This Indian Standard (Fifth Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Petroleum and their Related Products of Synthesis or Biological Origin Sectional Committee was approved by the Petroleum, Coal and Related Products Division Council.

This standard was originally published in 1960 and subsequently revised in 1967, 1982, 1994 and 2012.

The standard was originally published giving due consideration to various factors, such as economy, availability and quality as well as to the need for international coordination among recognized standards of other countries on the subject. In the first revision, additional gum inhibitors were included and changes were made in the requirements of colour, lean mixture rating, water reaction for 115/145 grade and aromatic content were specified. An additional grade of 80L was introduced. In the second revision, grades 91/96 and 115/145 were omitted and new grade 100LL was incorporated.

In the third revision, grades 73 and 100L have been omitted and only 2 grades namely, 100LL and 80 were retained and requirement were modified to suit the end use requirements. Approved additive system namely, antioxidants, static dissipater additives etc were included.

The fourth revision was necessitated by the changes in various factors like steady decrease in demand for aviation gasoline at international level and many of the foreign oil companies had started discontinuing the production of many grades of aviation gasoline especially low octane number fuels. Because of short supply and other growing difficulties, a common grade 100LL aviation gasoline is normally available in international market. In view of this, international airworthiness agencies like Federal Aviation Administration in USA and Civil Aviation Authority in UK have approved the use of MO GAS conforming to ASTM D4814-09 'Standard specification for automotive spark-ignition engine fuel' and BS 4040 : 2001 'Specification for leaded petrol (gasoline) for motor vehicle' (four star specification in low compression ratio engine having compression ratio 7.2 or less equipped in light aircraft general aviation purpose being an alternative fuel to 80/87 low octane aviation grade). However, the specification for 80/87 grade was retained till a substitute to this grade is indigenously available. Fourth revision was based on DEF STAN 91-90 (DERD 2485) (Issue 2, 31 March 2006) issued by the Ministry of Defence, UK, ASTM D 910-07. In fourth revision, parameters, such as dye concentration and water reaction were modified, exact name of the blue dye was included.

This fifth revision is a review of the existing standard considering the present-day requirements of the products and in order to align it with British Ministry of Defense specification DEF STAN 91-090 (Issue 5, 14 October 2019). Assistance was also derived from ASTM D 910-21 'Standard Specification for Leaded Aviation Gasolines'. The need for international coordination among recognized standards of other countries on the subject is particularly significant for the product of this type since re-fueling of aircraft in different countries is often involved. The approved additive systems, namely, antioxidants, metal deactivators (MDA), static dissipater additive (SDA), lubricity improver additive (LIA) and fuel system icing inhibitor (FSII), were adopted from DEF STAN 91-090 (Issue 5).

In this revision grade 80 has been deleted and grade UL91 and 100 have been incorporated along with details of fuel system cing inhibitor and corrosion inhibitor additive aligning it with international practices.

(*Continued on third cover*)

Indian Standard
AVIATION GASOLINE — SPECIFICATION
(Fifth Revision)

1 SCOPE

This standard prescribes requirements and methods of sampling and test for three grades (AVGAS UL91, AVGAS 100 and AVGAS 100LL) of gasoline type aviation fuel intended primarily for use in aircraft spark ignition reciprocating engines.

> NOTE — This standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 REFERENCES

The following standards contain provisions which, through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on the standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

IS/Other Publications	*Title*
1260 (Part 1) : 1973	Pictorial marking for handling and labelling of goods: Part 1 Dangerous goods (*first revision*)
1447 (Part 1) : 2021	Methods of sampling of petroleum and its products Part 1 Manual sampling (*second revision*)
1448	Methods of test for petroleum and its products
(Part 6) : 1984	Heat of combustion of liquid hydrocarbon fuels by bomb calorimeter method (*first revision*)
(Part 11) : 2004/ ISO 3013 : 1997	Petroleum products — Determination of freezing point of aviation fuels (*fourth revision*)
(Part 13) : 1960	Colour by Lovibond tintometer
(Part 15) : 2004/ ISO 2160 : 1998	Petroleum products — Corrosiveness to copper — Copper strip test (*third revision*)
(Part 16) : 2014/ ISO 3675 : 1998	Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method (*fourth revision*)
(Part 18) : 2020	Distillation of petroleum products (*third revision*)
(Part 26) : 2018/ ISO 5163 : 2014	Knock characteristics of motor and aviation fuels — Motor method (*second revision*)
(Part 27) : 2018/ ISO 5164 : 2014	Knock characteristics of motor fuels — Research method (*second revision*)
(Part 29) : 2021/ ISO 6246 : 2017	Petroleum products — Gum content of fuels — Jet evaporation method (*fourth revision*)
(Part 39) : 2012/ ISO 3007 : 1999	Determination of vapour pressure — Reid method (*second revision*)
(Part 42) : 2015/ ISO 6250 : 1997	Determination of the water reaction of aviation fuels (*third revision*)
(Part 46) : 1962	Knock characteristics of aviation fuels by the supercharge method
(Part 82) : 2008/ ISO 3830 : 1993	Petroleum products — Determination of lead content in gasoline — Iodine monochloride method (*first revision*)
(Part 148) : 2019/ ISO 6297 : 1997	Petroleum products — Aviation and distillate fuels — Determination of electrical conductivity (*first revision*)

IS/Other Publications	*Title*
(Part 153) : 2012/ ISO 20847 : 2004	Petroleum products — Determination of sulfur content of automotive fuels — Energy-dispersive X-Ray fluorescence spectrometry
(Part 167) : 2018/ ISO 12185 : 1996	Determination of density — Oscillating U-tube method

3 GRADES

The materials shall be of the following grades:

a) AVGAS UL91;
b) AVGAS 100; and
c) AVGAS 100LL.

4 REQUIREMENTS

4.1 General

4.1.1 The material shall meet required properties of aviation gasoline and shall give good performance when used in appropriate aero engines for which the particular grade of the material is specified by the manufacturer.

4.1.2 The material shall also comply with the quality requirements prescribed in Table 1 when tested according to the methods as given in col 6 of Table 1.

4.2 Composition

4.2.1 *Materials*

4.2.1.1 The fuel shall consist completely of hydrocarbon compounds, like blends of refined hydrocarbons derived from crude petroleum, natural gasoline or blends thereof, with synthetic hydrocarbons or aromatic hydrocarbons or both and the qualified additives specified in **4.2.2**.

4.2.1.2 Aviation gasoline is a complex mixture of hydrocarbons that varies depending on crude source and manufacturing process. Consequently, it is impossible to define the exact composition of aviation gasoline. This specification has therefore evolved primarily as a performance specification rather than a compositional specification.

4.2.1.3 For operational performance, aviation gasoline shall be hydrocarbon based fuel. Ethanol is not permitted to ensure broad compatibility with aircraft fuel systems, good water separation characteristics and flight range.

4.2.1.4 Additives shall be identified by the appropriate RDE/A/XXX number or by name as shown in this standard. The amount, including NIL additions, of all additive additions shall be reported to the purchaser on batch quality certificates or as otherwise directed by the purchaser and/or contract.

4.2.2 *Additives*

4.2.2.1 *Anti-oxidants*

A qualified anti-oxidant or a mixture of qualified antioxidants may be added to the material in order to prevent the formation of gum and the precipitation of lead compounds. The total concentration of the active anti-oxidant(s) added shall not exceed 24.0 mg/l.

The following antioxidant formulations are qualified:

Formulation	*Qualification Reference*
(a) 2, 6-ditertiary-butyl-phenol	RDE/A/606
(b) 2, 6 ditertiary-butyl-4-methyl-phenol	RDE/A/607
(c) 2, 4-dimethyl-6-tertiary-butyl-phenol	RDE/A/608
(d) 75 percent *Min*, 2, 6-ditertiary-butyl-phenol and 25 percent *Max*, tertiary and tritertiary-butyl-phenols	RDE/A/609
(e) 55 percent *Min*, 2, 4-dimethy l-6-tertiary-butyl-phenol and 15 percent *Min*, 4 methy l-2, 6-ditertiary-butyl-phenol Remainder, 30 percent *Max*, as a mixture of monomethyl and dimethyl-tertiary-butyl-phenols	RDE/A/610
(f) 72 percent *Min*, 2,4-dimethyl-6-tertiary-butyl-phenol and 28 percent *Max*, mixture of tertiary-butyl-methyl-phenols and tertiary-butyl dimethyl phenols	RDE/A/611

NOTE — The supplier shall, if required by the purchaser or his authorized agent, disclose the nature and concentration of anti-oxidants which has been added to the fuel supplied.

4.2.2.2 *Antiknock additive*

Tetraethyl lead shall be added to grades 100 and 100LL of the material in concentration not exceeding the limits specified in Table 1. The tetraethyl lead shall be in the form of anti-knock mixture containing not less than 61 percent by mass of tetraethyl lead and sufficient ethylene dibromide to provide two atoms of bromine per atom of lead. The balance shall contain no added ingredient other than kerosene, the qualified oxidation inhibitor and qualified dye as specified under **4.2.2**.

4.2.2.3 *Static dissipater additive (SDA)*

Where so required by the purchasing authority, in the interest of safe handling of product and/or aircraft, a qualified SDA may be added to the fuel to impart the required electrical conductivity. The concentration in which SDA is to be added to the fuel shall not exceed 3.0 mg/l.

NOTE — The following material is qualified:

Product	*Manufacturer*	*Qualification Reference*
Stadis 450	Innospec LLC	RDE/A/621

4.2.2.4 *Dye (grade identification)*

The following dye shall be used to give the finished fuel for appropriate grade identification, in concentrations specified in below:

a) Blue essentially 1, 4 dialkylamino-anthraquinone.

b) Yellow essentially diethylaminoazobenzene or 1,3-benzenediol, 2-4-bis(alkyl(phenol)azo)-]

Dye	*Concentration, mg/l, Max*	
	Grade 100	Grade 100LL
Blue	2.7	2.7
Yellow	2.8	None

4.2.2.5 *Fuel system icing inhibitor (FSII)*

A qualified FSII may be added to the fuel as agreed to between the purchasing authority and the supplier. Concentrations less than 0.02 percent by volume can be considered negligible and do not require agreement/notification. The assent to allow these small quantities of FSII without agreement/notification is to facilitate the changeover from fuels containing FSII where the additive may remain in the fuel system for a limited time. This does not allow the continuous addition of FSII at these low concentrations.

The following materials are qualified and shall comply with Def Stan 68-252:

Product	**Qualification Reference**	**Concentration**
Diethylene Glycol Monomethyl Ether (DiEGME)	RDE/A/630	The concentration of DiEGME[1] shall not be less than 0.10 percent and not more than 0.15 percent by volume at the time of the delivery to the purchaser.
Propan-2-ol (Isopropyl Alcohol)	ASTM D4171 (Type II)	The concentration of Isopropyl Alcohol[2] shall be recommended by the aircraft manufacturer at the time of delivery to the purchaser and typically not exceeding 1 percent, by volume.

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[1] A suitable method for determining DiEGME concentration is ASTM D5006.

[2] Suitable methods for determining Isopropyl Alcohol concentration are IP 566 and ASTM D4815.

4.2.2.6 *Corrosion inhibitor additive*

The following corrosion inhibitors may be added to the gasoline in concentrations not to exceed the maximum allowable concentration listed for each additive:

Product	Manufacturer	Qualification Reference	Maximum, mg/l
Hitec 580	Afton Chemical Ltd.	RDE/A/661	22.5
Octel DCI-4A	Innospec LLC	RDE/A/662	22.5
Octel DCI-6A	Innospec LLC	RDE/A/663	9.0
Nalco 5403	Nalco Chemical Co.	RDE/A/664	22.5
Tolad 4410	Baker Petrolite	RDE/A/665	22.5
Tolad 351	Baker Petrolite	RDE/A/666	24.0
Unicor J	Dorf Ketal Chemicals	RDE/A/667	22.5
Nalco 5405	Nalco Chemical Co.	RDE/A/668	11.0
Spec Aid 8Q22	GE Betz	RDE/A/669	24.0

5 SAMPLING

5.1 Representative samples of material shall be drawn as prescribed in IS 1447 (Part 1).

5.2 Representative samples of each batch of the product shall be tested to prove homogeneity. On proving homogeneity, all characteristics given in the standard shall be tested on composite sample prepared by mixing representative samples, proportionately.

5.3 The batch/lot shall be declared as conforming to the requirements of the standard, if all the test results on the composite sample meet the requirements as prescribed in Table 1.

6 PACKING AND MARKING

6.1 Packing

The material shall be packed in suitable clean containers as agreed between the purchaser and the supplier, subject to statutory requirements in force in the country.

6.2 Marking

The material shall be supplied in accordance with the marking and delivery instructions given by the purchaser.

6.2.1 Each container shall also be marked with the following information:

a) Name and grade of the material;
b) Indication of the source of manufacture, initials or trade-mark, if any;
c) Volume of the contents, in litres;
d) Year of manufacture or packing; and
e) Any other statutory requirements.

6.2.2 Each container shall also be marked with the caution label '**HIGHLY FLAMMABLE**' together with the corresponding symbol for labeling dangerous goods [IS 1260 (Part 1)].

6.2.3 *BIS Certification Marking*

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the rules and regulations framed thereunder, and the products may be marked with the Standard Mark.

7 HANDLING, STORAGE AND QUALITY ASSURANCE

For the safe handling and storage of the fuel the instructions given in Aviation Quality Control and Assurance Manual (AQCAM) attested by DGCA shall be followed. Fuel quality assurance is given in Annex A.

Table 1 Requirement for Aviation Gasoline

(*Clauses* 4.1.2, 4.2.2.2, 5.3, A-1, A-3 *and* A-7)

Sl No.	Characteristics	Requirements			Method of Test, Ref to parts of IS 1448/ISO/ASTM/IP
		Grade UL91	Grade 100	Grade 100LL	
(1)	(2)	(3)	(4)	(5)	(6)
i)	Appearance	Clear, bright and visually free from solid matter and undissolved water at ambient temperature			Visual examination
ii)	Colour visual$^{1)}$	Undyed	Green	Blue	Visual
iii)	Colour lovibond$^{2)}$				Part 13$^{3)}$/IP 569
	Blue	–	1.7 to 3.5	1.7 to 3.5	
	Yellow	–	1.5 to 2.7	–	

Table 1 (*Concluded*)

Sl No.	**Characteristics**	**Requirements**			**Method of Test, Ref to parts of IS 1448/ISO/ASTM/IP**
		Grade UL91	**Grade 100**	**Grade 100LL**	
(1)	(2)	(3)	(4)	(5)	(6)
iv)	Copper strip corrosion for 2 h at 100 °C, *Max*		1		Part 15[3]/IP 154/D130
v)	Density at 15 °C, kg/m^3		← Report →		Part 16[3]/Part 167/IP 365/D 4052
vi)	Distillation:				
	a) Initial boiling point, at °C		← Report →		
	b) 10 percent *v/v* evaporated at °C, *Max*		← 75 →		
	c) 40 percent *v/v* evaporated at °C, *Min*		← 75 →		
	d) 50 percent *v/v* evaporated at °C, *Max*		← 105 →		
	e) 90 percent *v/v* evaporated at °C, *Max*		← 135 →		Part 18[3]/IP 123/D 86
	f) Final boiling point at °C, *Max*		← 170 →		
	g) Sum of 10 percent and 50 percent fuel evaporated temperatures °C, *Min*		← 135 →		
	h) Residue, percent *v/v*, *Max*		← 1.5 →		
	j) Loss, percent *v/v*, *Max*		← 1.5 →		
vii)	Electrical conductivity, pS/m		[4]		Part 148[3]/IP 274/D 2624
viii)	Existent gum, mg/100 ml, *Max*		← 3.0 →		Part 29[3]/IP 131/D381
ix)	Freezing point[5], °C, *Max*		← (–) 58 →		Part 11[3]/IP 16/D2386
x)	Knock rating[6]:				
	a) Lean mixture, motor method, octane number, *Min*	91.0	99.6	99.6	Part 26[3]/IP 236/D2700
	b) Research, octane number, *Min*	95.0	—	—	Part 27[3]/D 2699
	c) Performance number, *Min*	[7]	130.0	130.0	Part 46[3] / IP 119/ D909
xi)	Oxidation stability, 16 h:				
	a) Potential gum, mg/100 ml, *Max*		← 6 →		IP 138/D873[3]
	b) Precipitate, mg/100 ml, *Max*		← 2 →		
xii)	Reid vapour pressure at 37.8 °C, kPa		← 38.0 to 49.0 →		Part 39[3]/IP 69/D323
xiii)	Specific energy MJ/kg, *Min*		← 43.5 →		Part 6[3]/IP 12
xiv)	Total sulphur percent *m/m, Max*		← 0.05 →		D5453[3]/IP 107/D1266
xv)	Tetraethyl lead[8], gPb/l	0.013 *Max*[9]	0.28 to 0.85	0.28 to 0.56	Part 82[3]/IP 270/D3237
xvi)	Water reaction, volume change, ml, *Max*		2		Part 42[3]/IP 289/D1094

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[1] Colour visual must also comply with test at Sl No. (iii) of the table.

[2] IP 17 has been replaced by IP 569. A 50.8 mm cell shall be used. IP 17 is allowed as an alternative method.

[3] In case of disputes, this method shall be the referee method.

[4] Where so required by purchasing authority, SDA may be added to fuel to attain the conductivity at the point, time and temperature of delivery to the purchaser shall be in the range 50 to 600 pS/m.

[5] If no crystals appear when the thermometer indicates a temperature of – 58 °C, the freezing point shall be recorded as below – 58 °C.

[6] Knock rating shall be reported to the nearest 0.1 for octane number and performance number.

[7] If mutually agreed upon between the purchaser and supplier, a minimum 98 octane requirement as per test method IP-119/ASTM D 909 may be specified.

[8] For grade UL91, ASTM D 3237 is applicable.

[9] For grade UL91 maximum lead limit applies at the point of manufacture.

ANNEX A

(*Clause* 7)

QUALITY ASSURANCE

A-1 Aviation fuel quality assurance is based on two key concepts: Batch and Traceability. Representative sample of each batch of the finished product shall be tested to ensure batch homogeneity and compliance with the requirement of Table 1 of this standard. A batch of fuel is defined as a distinct quantity of fuel that can be characterized by one set of test results.

A-2 At the point of manufacture, the refinery shall issue a certificate of quality of fuel for each batch to demonstrate the compliance of this standard including details of additives added.

A-3 To certify compliance with Table 1 limits, representative samples shall be drawn using appropriate procedures such as those outlined in IS 1447 (Part 1). Each homogeneous batch of the finished product shall be tested against the requirements of Table 1. Results shall be reported on the appropriate batch certificate of quality. This requirement is not satisfied by averaging on-line analysis results. The minimum information to be included in the fuel's batch test certificate of quality at point of manufacture is as under:

a) Specification name, issue and any amendment number;
b) Name and address of testing laboratory;
c) Batch number or unique identifier;
d) Quantity of fuel in the tank/batch;
e) Properties tested including specification limit, test method and test result;
f) Additives, including qualification reference and quantity added;
g) Name and position of authorised test certificate signatory or electronic signature; and
h) Date of certification.

Documentation shall be provided by the supplier to the purchaser to show that the fuel meets the requirements of this standard and demonstrates traceability to point of manufacture. Upon request the technical authority or end user shall be provided with the documentation

A-4 The technical authority, purchaser or end user reserves the right to require additional testing of the product at any time and to sample and test the product and/or ingredients at any time during or after manufacture.

A-5 If any sample taken from the consignment is found not to comply with the requirements of this standard, the whole consignment may be rejected.

A-6 Materials used in refinery processing might be carried over in trace quantities into aviation fuels and have been known to cause operational problems in aircraft fuel systems. Appropriate management of change measures should be used at manufacturing locations to manage the risk of this type of contamination in aviation fuels (*see* **A-7**).

A-7 CONTAMINATION BY PROCESSING ADDITIVES

Experience has shown that refinery processing additives, such as corrosion inhibitors, might be carried over in trace quantities into aviation fuel during refinery production. In some cases, this has resulted in operational problems in aircraft fuel systems. Moreover, these additives can cause problems at levels which may not be detected by the standard specification testing detailed in Table 1. Only approved additives given in **4.2.2** shall be used.

A-7.1 It is therefore not practical for this standard to require detailed chemical analysis of each production batch of aviation fuel beyond the requirements listed in this standard. Instead, it is recommended that manufacturing locations ensure that they have adequate quality assurance and management of change procedures in place to ensure that refinery processing additive use is well defined and controlled. Any changes in additive composition/manufacturing source or refinery processing conditions should be subject to a formal risk assessment to ensure maintenance of finished product quality.

A-7.2 Due to known problems arising from the carry-over of the refinery processing additive (corrosion inhibitor) 1, 2-diaminoethane (ethylene diamine), its use is specifically not recommended in the manufacture of aviation gasoline.

ANNEX B

(*Foreword*)

COMMITTEE COMPOSITION

Petroleum and their Related Products of Synthesis or Biological Origin Sectional Committee, PCD 03

Organization	*Representative(s)*
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Petroleum and Explosives Safety Organization, Nagpur	Dr S. K.Dixit Shri Ninad Gawade (*Alternate*)

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TVS Motor Company Ltd, Hosur, Tamil Nadu	Dr Jabez Dhinagar Shri Anand Kumar M. S. (*Alternate*)
BIS Directorate General	Shrimati Nagamani. T, Scientist 'E' and Head (PCD) [Representing Director General (*Ex-officio*)]

Member Secretary

Shrimati Nagamani. T
Scientist 'E' and Head (PCD), BIS

Automotive, Aviation and Industrial Fuels Subcommittee, PCD 3 : 1

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Ashok Leyland Limited, Chennai	Shri Mahesh P. Shri D. Balakrishnan (*Alternate*)
Automotive Research Association of India, Pune	Shri M. A. Bawase Dr S. S. Thipse (*Alternate*)
Bajaj Auto Limited, Pune	Shri Yogesh. R. Mahajan
Bharat Oman Refineries Limited, Bina	Shri B. Sridhar Shri Bharat Kumar Sharma (*Alternate*)
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Tata Motors Limited, Pune	Shri T. Sethuramalingam Shri Pallipalayam Gowrishankar (*Alternate*)
Ultra Plus Lubes Private Limited, Panvel	Shri Siddesh N. Savant Shri N. C. Sekharan (*Alternate*) Shrimati Rohini Nikam (*Young Professional*)

(*Continued from second cover*)

The following alternate test methods are also available for the characteristics stated and in case of dispute the corresponding parts of IS 1448, as given in Table 1 of this standard shall be the referee test method:

Characteristic	*Alternate Method of Test*
Appearance	ASTM D4176 Procedure 1
Total sulphur	ASTM D2622, IP 243,
Vapour pressure	IP 394*, ASTM D 5191*
Density at 15 °C	ISO 12185, IP 160/ASTM D1298
Tetraethyl lead content	IP 228/ASTM D5059, IP 428/ASTM D3341
Specific energy	ASTM D3338, ASTM D4809, ASTM D4529/IP 381
Colour, Lovibond	IP 17(using a 50.8 mm cell), ASTM D2392

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* Results shall be reported as dry vapour pressure equivalent (DVPE), as defined in the approved alternative method used.

The composition of the Committee responsible for the formulation of this revision is given in Annex B.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded value should be the same as that of the specified value in this standard.

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